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Ion-scale secondary island flux-ropes in magnetopause reconnection as resolved by MMS

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Magnetic reconnection on the dayside magnetopause of the Earth's magnetosphere leads to the formation of flux transfer events (FTEs), whose primary signature is a bipolar variation in the component of the magnetic field perpendicular to the magnetopause plane. Many FTEs exhibit a flux rope type structure, and several different formation mechanisms have been proposed, including: as a consequence of patchy reconnection; bursty reconnection at a single X-line; or multiple X-line reconnection.

Here we present new observations from the four-spacecraft Magnetospheric MultiScale mission of FTE-type structure observed at the dayside magnetopause. These FTE structures last only a few seconds, and are embedded in a reconnection jet that is close to a reconnection X-line. They are identified as flux rope type islands produced by secondary reconnection processes. We examine the structure and properties of the flux ropes using multispacecraft techniques applied to the MMS data where the spacecraft were separated by only 10 km. Measurements of the ion and electron from the Fast Plasma Instrument are used to calculate the flux rope current density and this is compared with current densities calculated from the four-point magnetic field measurements. The velocity moments together with measurements of the electric and magnetic field are also used to examine the sub-structure of the flux rope and assess differences in the ion and electron behaviour inside the flux rope on ion-scales and below. This reveals flux-rope sub-structure in new detail which is compared with the output of particle-in-cell simulation.